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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

EEE3096 – COMMUNICATION ELECTRONICS
(TE, MCE)

13th OCTOBER 2015
2:30 P.M. – 4:30 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages with 4 Questions only .
 2. Attempt **ALL FOUR** questions .
 3. Please print all your answers in the Answer Booklet provided.
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Question 1

- (a) Define the following components in communication electronics:

- (i) amplifier, and
- (ii) attenuator.

[2 marks]

- (b) Fig. Q1b shows two identical L-attenuators in cascade.

- (i) Given that $V_{in} = 100 \text{ V}$, $V_{out} = 10 \text{ V}$ and $R_L = 100 \Omega$, determine the value of R_1 , R_2 , R_3 , and R_4 when the image impedance Z_i is matched to the load R_L .

[3 marks]

- (ii) Suppose that a source resistance R_S is present, using the value of R_1 , R_2 , R_3 , and R_4 found in (i), calculate R_S if an output voltage $V_{out} = 9 \text{ V}$ is observed in the cascaded network.

[2 marks]

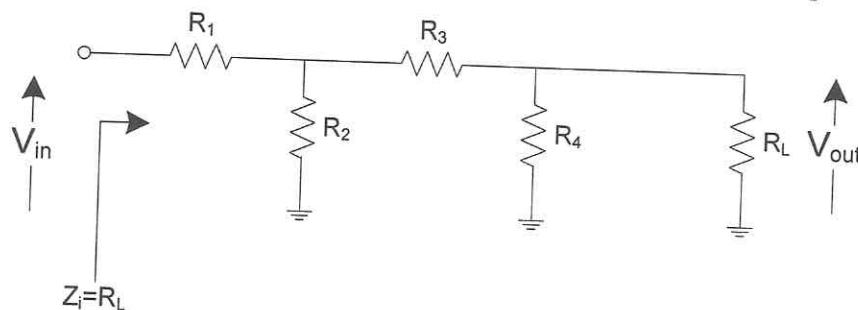


Fig. Q1b

- (c) Determine the 3 dB bandwidth of the two circuits shown in Fig. Q1c, both before and after adding a $2 \mu\text{H}$ inductor in series. Sketch and compare the frequency response results for both circuits. Comment on the differences in terms of bandwidth and selectivity.

[10 marks]

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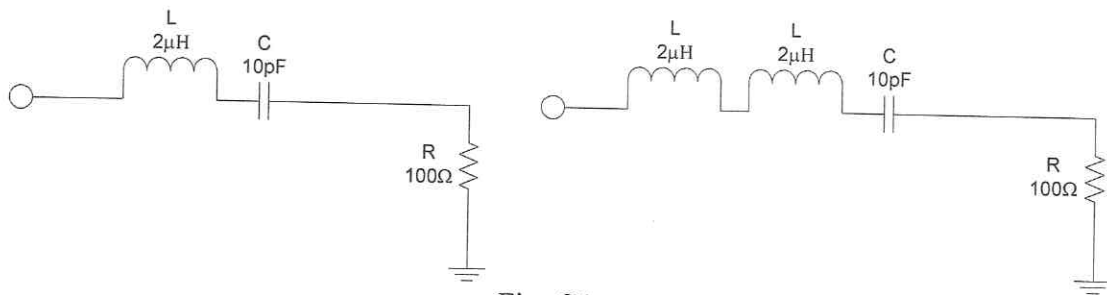


Fig. Q1c

- (d) Design an impedance matching using L-network for a circuit with source impedance $R_S = 200 \Omega$ and load impedance, $R_L = 400 \Omega$, $X_L = 0$ at a frequency of 100 MHz. Sketch and label all the values for each component of the network. [8 marks]

Question 2

- (a) Draw the frequency response for the tuned and untuned amplifier. [3 marks]
- (b) With the aids of suitable diagrams, explain two methods of neutralization. [4 + 4 marks]
- (c) The transistor in Figure Q2c has the following parameters: $r_{bb'} = 50 \Omega$, $h_{fe} = 200$, $V_A = 50 \text{ V}$, $C_c = 12 \text{ pF}$, $f_T = 250 \text{ MHz}$ and $V_{BE} = 0.7 \text{ V}$. The amplifier is designed to operate at 10 MHz with an operating bandwidth of 1 MHz. The transistor is biased at $I_C = 5 \text{ mA}$, $V_{CE} = 0.8 V_{CC}$ and $I_{Rb1} = 0.1 I_C$.
- (i) Determine g_m , $r_{b'e}$, r_{ce} , C_e , R_o and C_T . [9 marks]
- (ii) Determine the value of the inductance L and capacitance C of the tank network. [5 marks]

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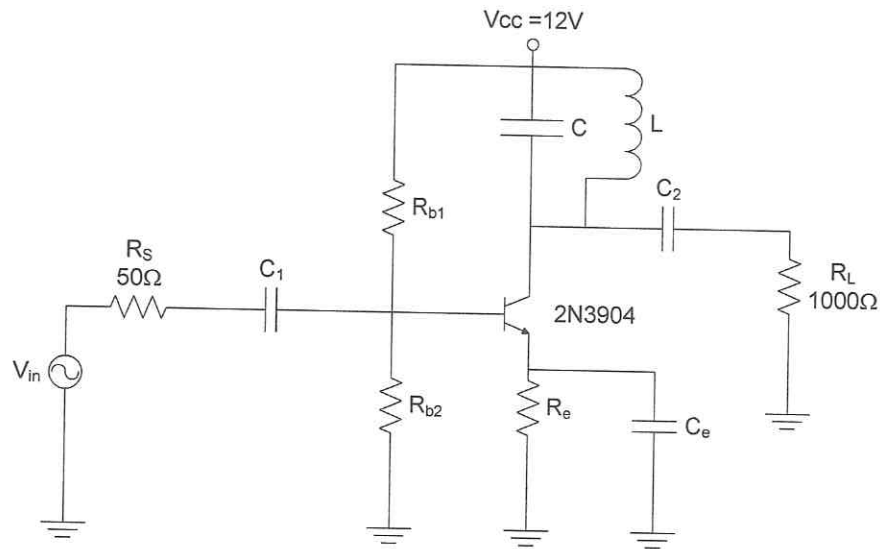


Fig. Q2c

Question 3

- (a) Explain the functions of phase detector, loop filter, and voltage controlled oscillator (VCO), in phase locked loops (PLL).
[6 marks]
- (b) With the aids of suitable diagram, explain capture range and lock range of a PLL?
[6 marks]
- (c) Fig. Q3c shows a frequency synthesizer used for channel selection in a superheterodyne receiver.
- Explain the rationale for having the “÷2000” and pre-scaler frequency divider.
[2 + 3 marks]
 - Determine N for an VCO output of 204.8 MHz.
[4 marks]
 - Determine the PLL open loop gain when the output is 204.8 MHz.
[4 marks]

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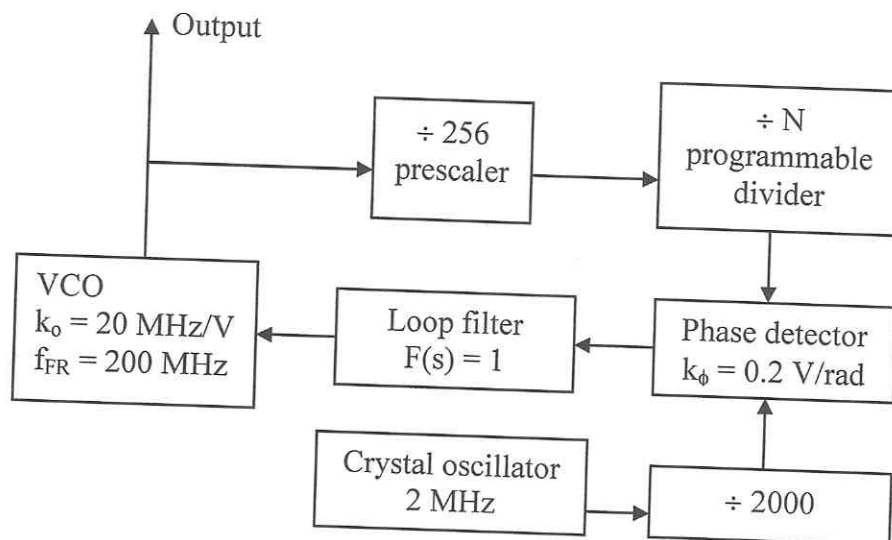


Fig. Q3c

Question 4

- (a) Give the pros and cons for Double Sideband - Large Carrier (DSB-LC), Double Sideband - Suppressed Carrier (DSB-SC), Single-sideband (SSB) and Frequency Modulation (FM) in transmitting TV signal. Hence, explain why Vestigial Sideband (VSB) with carrier is chosen as the favorable approach to transmit television signal. [10 marks]
- (b) Explain the basic working principle of gated automatic gain control (AGC). Explain why gated AGC is preferred over AGC using averaging or peak detector in television (TV) receivers. [6 marks]
- (c) A monochrome television (TV) channel was allocated a 6 MHz bandwidth. Using suitable diagrams, explain how chrominance information is fitted into the same 6 MHz bandwidth for colour TV transmission and why it is possible. [5 marks]
- (d) Given that National Television System Committee (NTSC) defines a frame rate of 30 fps with 525 lines per frame. Determine the field and line frequency. [4 marks]

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Appendix – Useful Formulas

1. L impedance matching network (when $R_L > R_S$):

$$B = \frac{X_L \pm \sqrt{R_L / R_S} \sqrt{R_L^2 + X_L^2 - R_S R_L}}{R_L^2 + X_L^2}$$

$$X = \frac{1}{B} + \frac{X_L R_S}{R_L} - \frac{R_S}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

2. L impedance matching network (when $R_L < R_S$):

$$B = \pm \frac{\sqrt{(R_S - R_L) / R_L}}{R_S}$$

$$X = \pm \sqrt{R_L (R_S - R_L)} - X_L$$

$$Q = R_S |B|$$

3. π impedance matching network:

$$L = L_1 + L_2 = \frac{R_L}{\omega_o} \left(\sqrt{R_S / R_L - 1} + \sqrt{R_L / R_L - 1} \right)$$

$$C_1 = \frac{1}{\omega_o R_S} \sqrt{\frac{R_S}{R_L} - 1}$$

$$C_2 = \frac{1}{\omega_o R_L} \sqrt{\frac{R_L}{R_L} - 1}$$

$$Q = \sqrt{\frac{R_S}{R_L} - 1} + \sqrt{\frac{R_L}{R_L} - 1}$$

4. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	The base-spreading resistance.
g_m	The transconductance. $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C \text{ (in mA)}}{25.875 \text{ mV}}$ at $T=300\text{K}$, q = electronic charge, $1.6 \times 10^{-19} \text{C}$
C_e	The emitter capacitance.
$r_{b'e}$	The input resistance. $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	The collector to base resistance. $r_{b'c} = h_{fe} r_{ce}$
C_C	The collector capacitance.
r_{ce}	The output resistance. $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

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5. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} \ll r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_S + r_{bb'}) \ll r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

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